

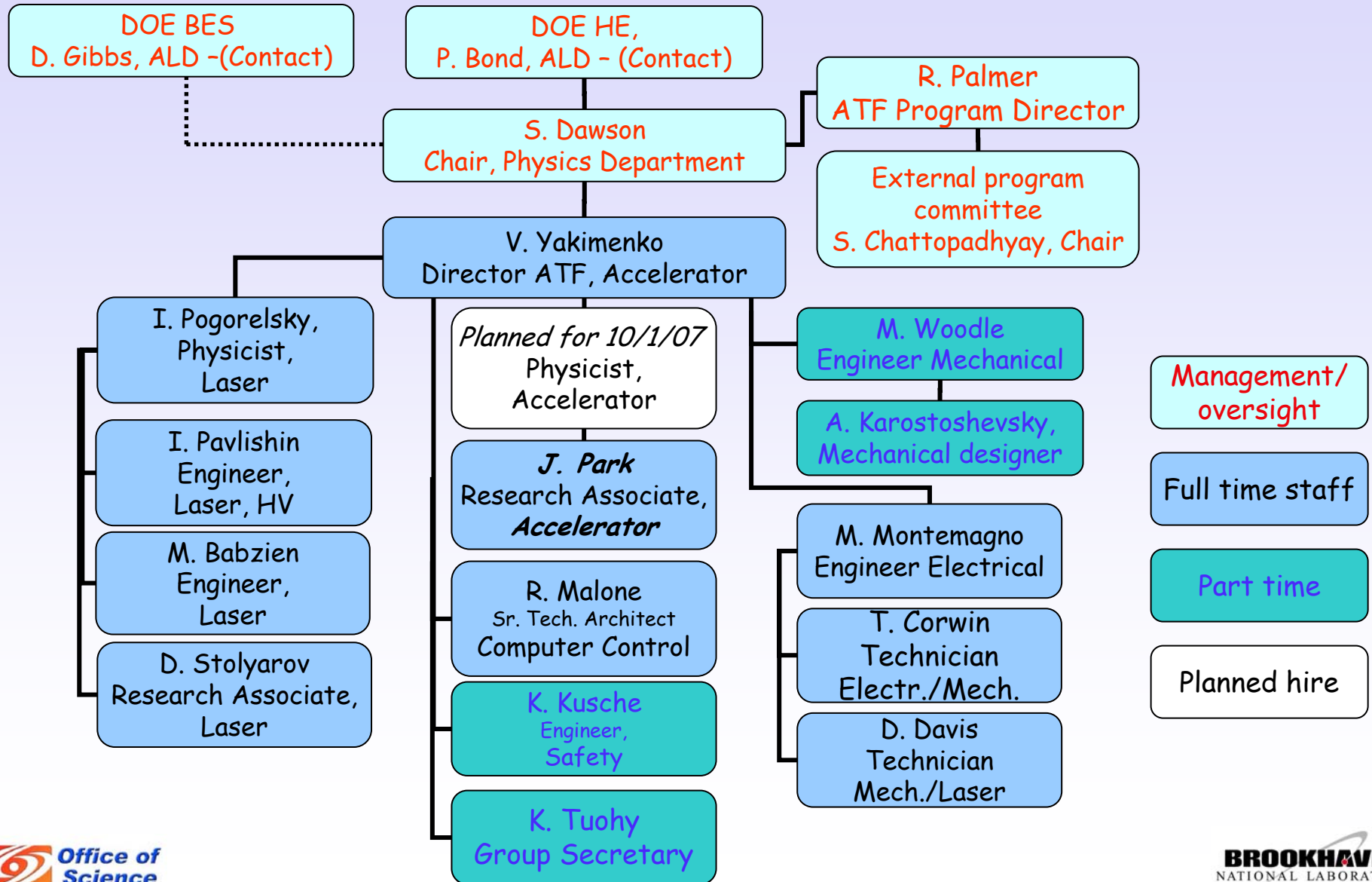
# Accelerator Test Facility at Brookhaven National Laboratory

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April 17, 2007

# People

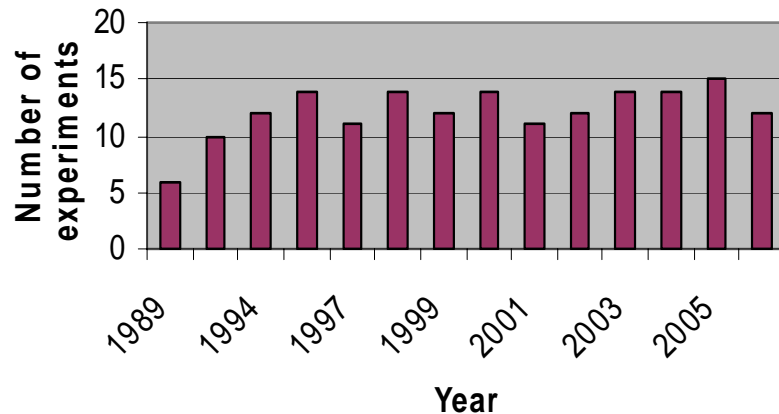
- ATF accelerator support was reduced by 2 scientific accelerator positions in recent years
  - due to budget constraints and necessity to increase support of laser systems.
- This severely affects user experience at ATF.
- Previously provided by ATF, support in electron beam delivery became the experimental group's responsibility.
- This is already the case for some long term experiments: STELLA (LWFA), VISA, DWA/ LACARA.
- Smaller scale experiments were negatively affected the most.
- Extra support of laser operations improved laser system performance and reliability.
- ATF has hired Dr. J. Park and is planning an additional hire to solve this issue.

# ATF Org. Chart

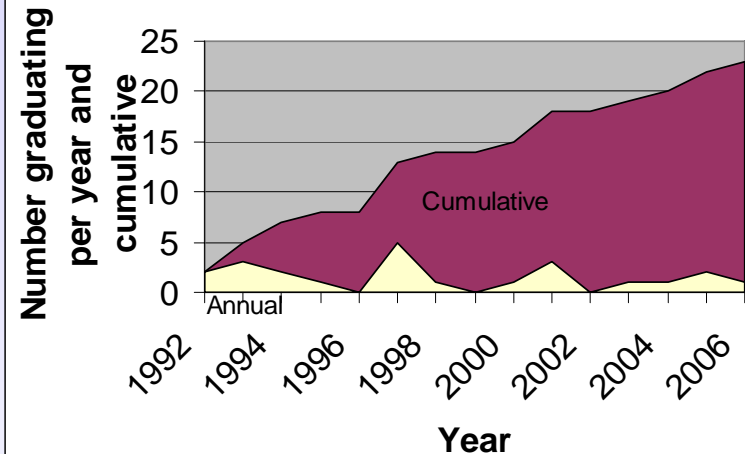


# ATF Statistics

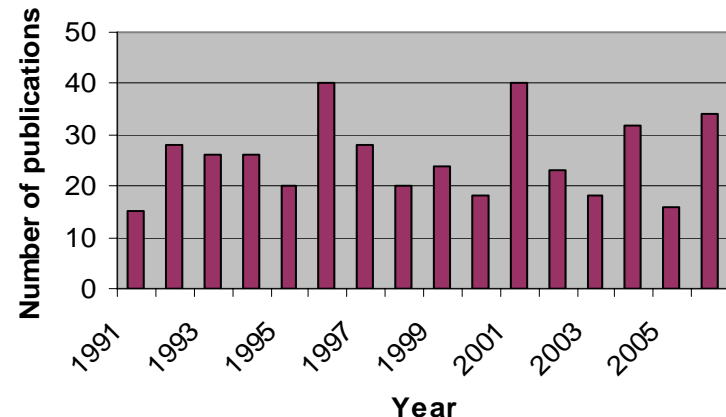
## ATF Experiments



## ATF Graduating Students



## ATF publications



Run time: ~ 1000 hour / year  
Graduated students: 22  
Current number of experiments: 12  
Staff members: 11, 1 visitor  
Phys Rev X: ~ 3 / year since 1995

## What was published in Phys. Rev. X in FY06?

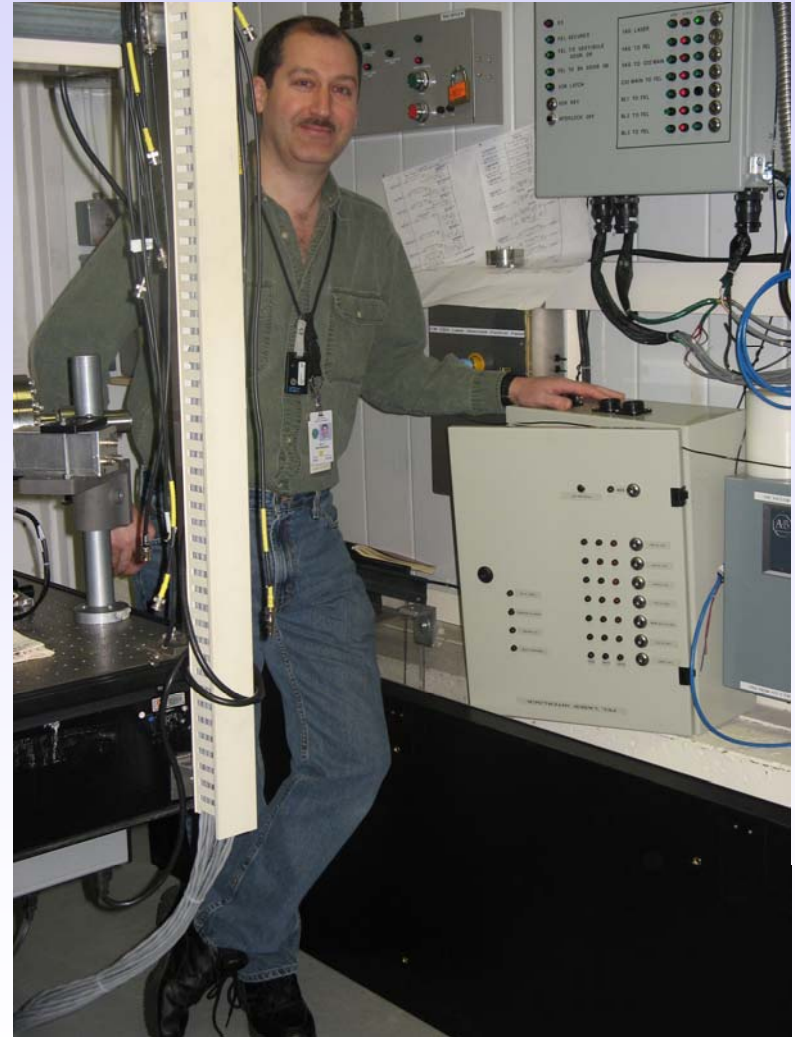
1. Experimental Observation of Direct Particle Acceleration by Stimulated Emission of Radiation Samer Banna, *et al.*, Phys. Rev. Lett. 97, 134801 (2006)
2. Observation of the Second Harmonic in Thomson Scattering from Relativistic Electrons Marcus Babzien *et al.* Phys. Rev. Lett. 96, 054802 (2006)
3. Observation of Anomalously Large Spectral Bandwidth in a High-Gain Self-Amplified Spontaneous Emission Free-Electron Laser G. Andonian *et al.* Phys. Rev. Lett. 95, 054801 (2005)
4. Observation of coherent THz edge radiation from compressed electron beams G. Andonian *et al.* Submitted to Phys. Rev. Lett. (2006)
5. Particle acceleration by stimulated emission of radiation: Theory and experiment Samer Banna, *et al.*, Phys. Rev. E 74, 046501 (2006)
6. Polarized source based on Compton backscattering in a laser cavity V. Yakimenko and I. V. Pogorelsky Phys. Rev. ST Accel. Beams 9, 091001 (2006)
7. Interference of diffraction and transition radiation and its application as a beam divergence diagnostic R. B. Fiorito, *et al.* Phys. Rev. ST Accel. Beams 9, 052802 (2006)
8. Experimental characterization of the transverse phase space of a 60-MeV electron beam through a compressor chicane F. Zhou *et al.* Phys. Rev. ST Accel. Beams 9, 114201 (2006)

# ATF priorities

- Support of existing experimental program
- Increased interaction with Brookhaven Facilities (eRHIC, RHIC-II, NSLS-II, ...)
- Upgrades: provide beams that are needed for loyal ATF users and to attract new users
- Improve beam quality and diagnostics (electron and lasers)
- Capitalize on the ATF strength: shared expertise between different experiments

# Interlock systems upgrade

- Interlock service at ATF is conducted by CAD group after ATF move into Physics department
- Radiation interlock (RI) hardware is old and urgently needs replacement
- Laser interlock (LI) needs improved documentation and complete reprogramming
- RI hardware upgrade started for the bunch compressor
- We expect to finish LI and RI this year





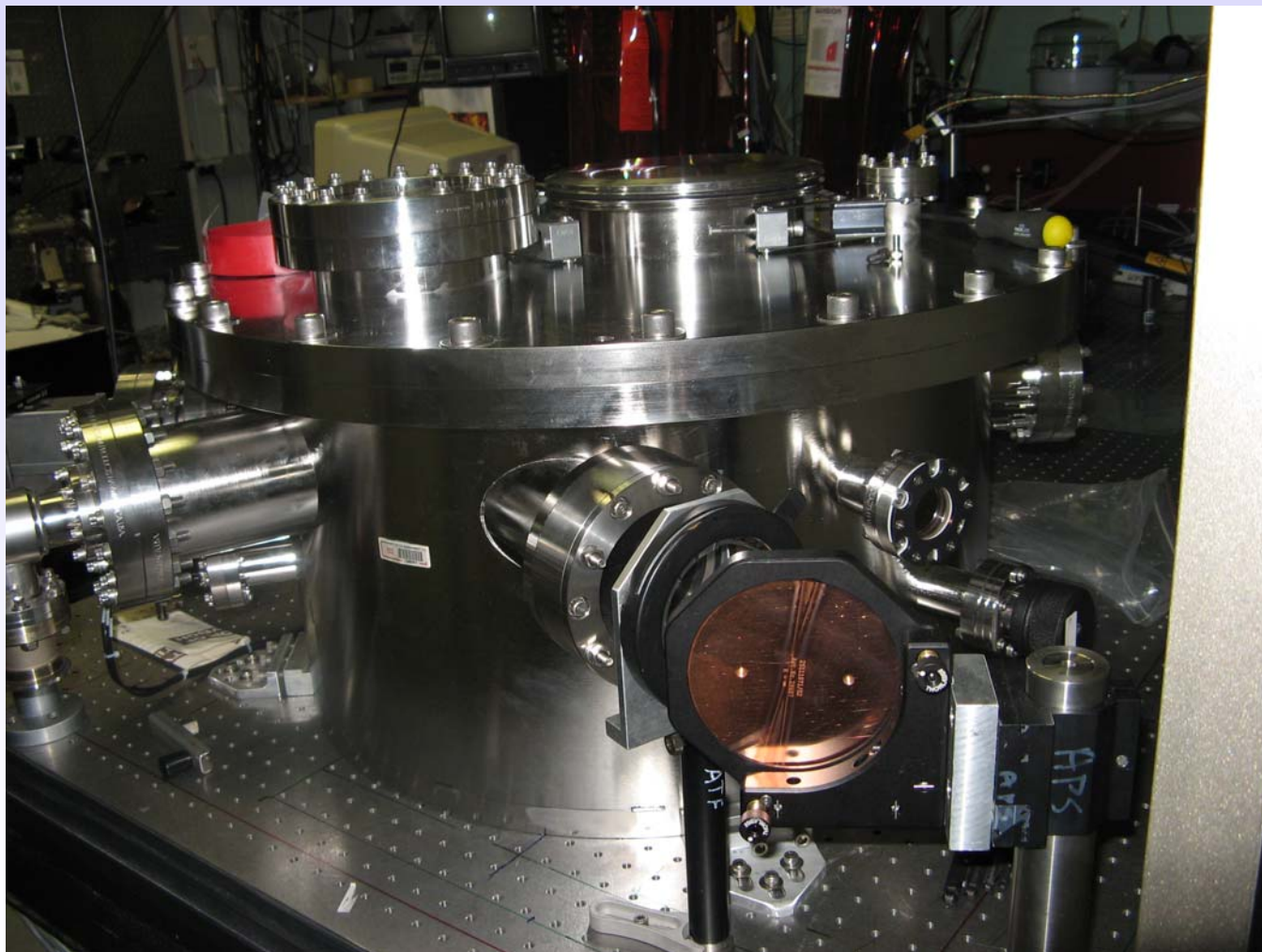
# Alignment laser from cathode to faraday cap

- Alignment laser is used to perform beam based alignment from gun to the end of H-line
- GUN-solenoid-LINAC misalignment were studied with this technique
- Mirror in the first dipole will send laser beam to verify alignment of the F-line
- Degaussing of the dipoles in combination with laser along F-lane will benefit:
  - Beam energy selection
  - Microbunch generation with wire mesh

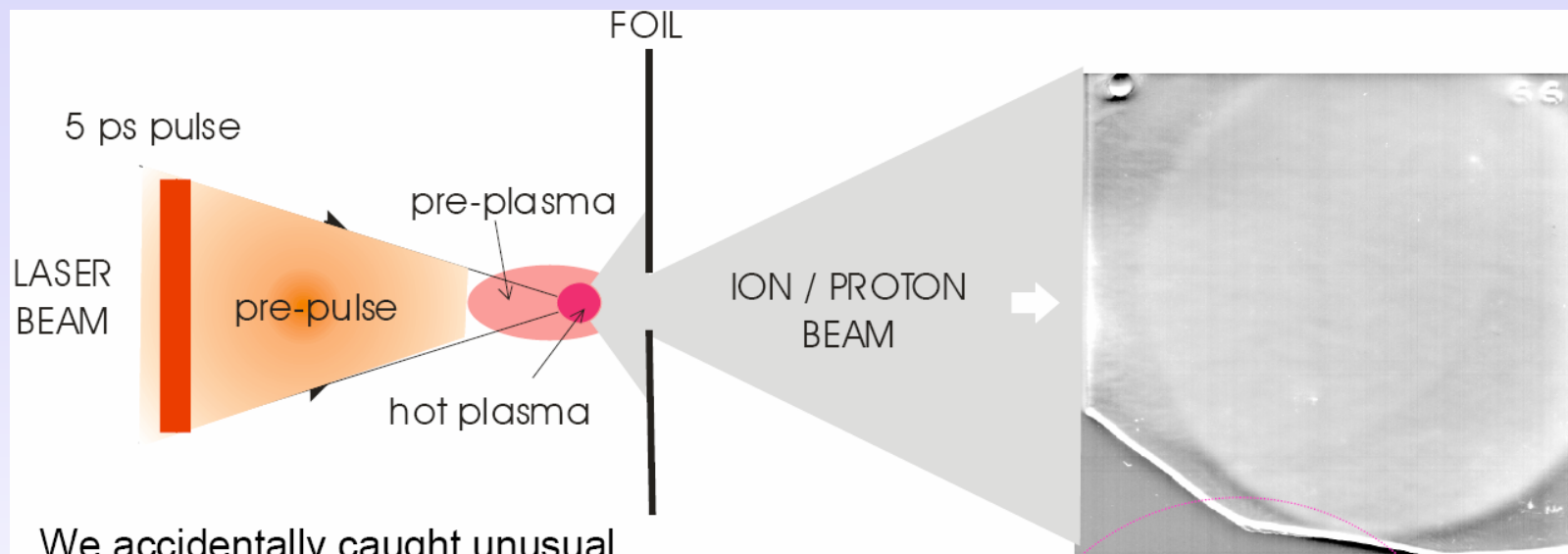




# New experimental chamber for CO<sub>2</sub> laser experiment

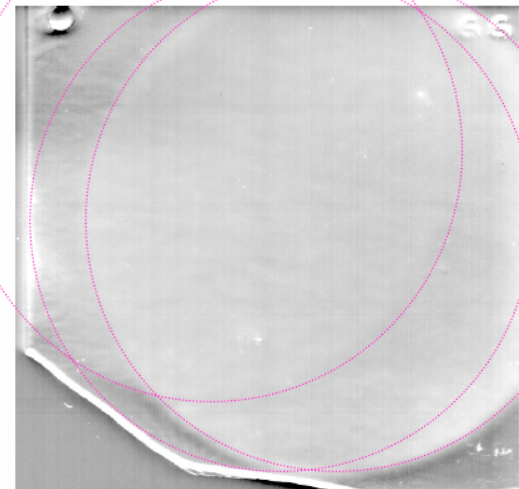


# Observation of "super-charged" ion circular beams

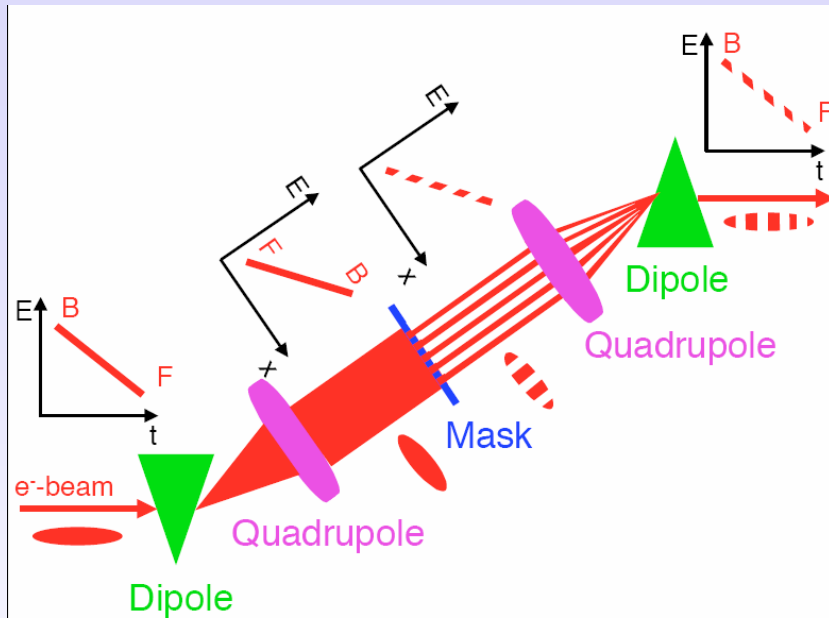


We accidentally caught unusual regime of generating high-charge circular beams. Hypothetical configuration is shown on a scheme. Sharp round boundary could be a shadow of a hole in foil burned by a pre-pulse.

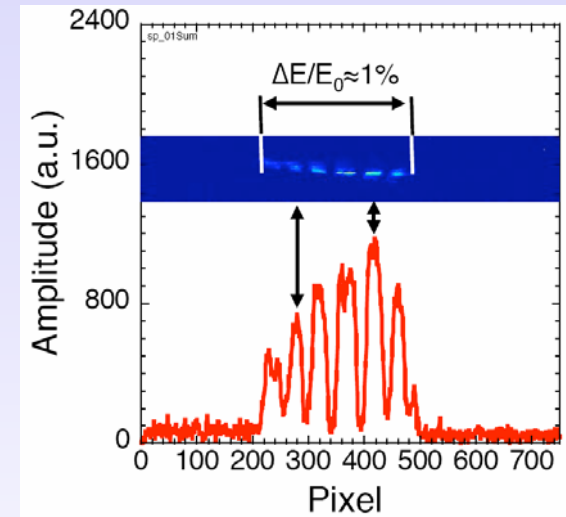
3 shots on 2x2" CR39 plate show 3 overlapping circles



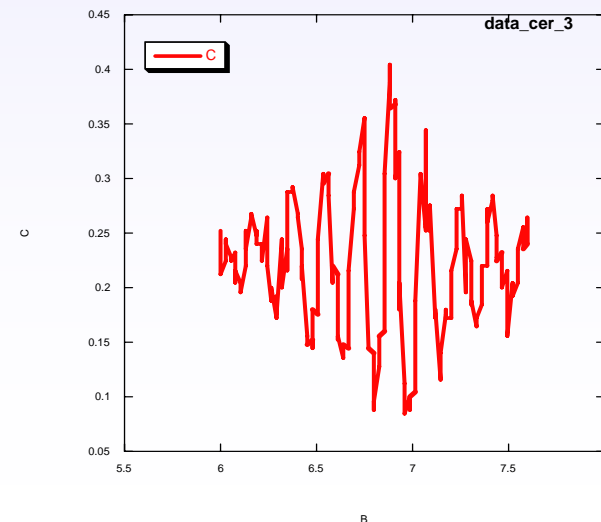
# Micro bunch formation with wire mesh (P. Muggli et al.), (Sources and instrumentation)



End of the line energy spectrometer:



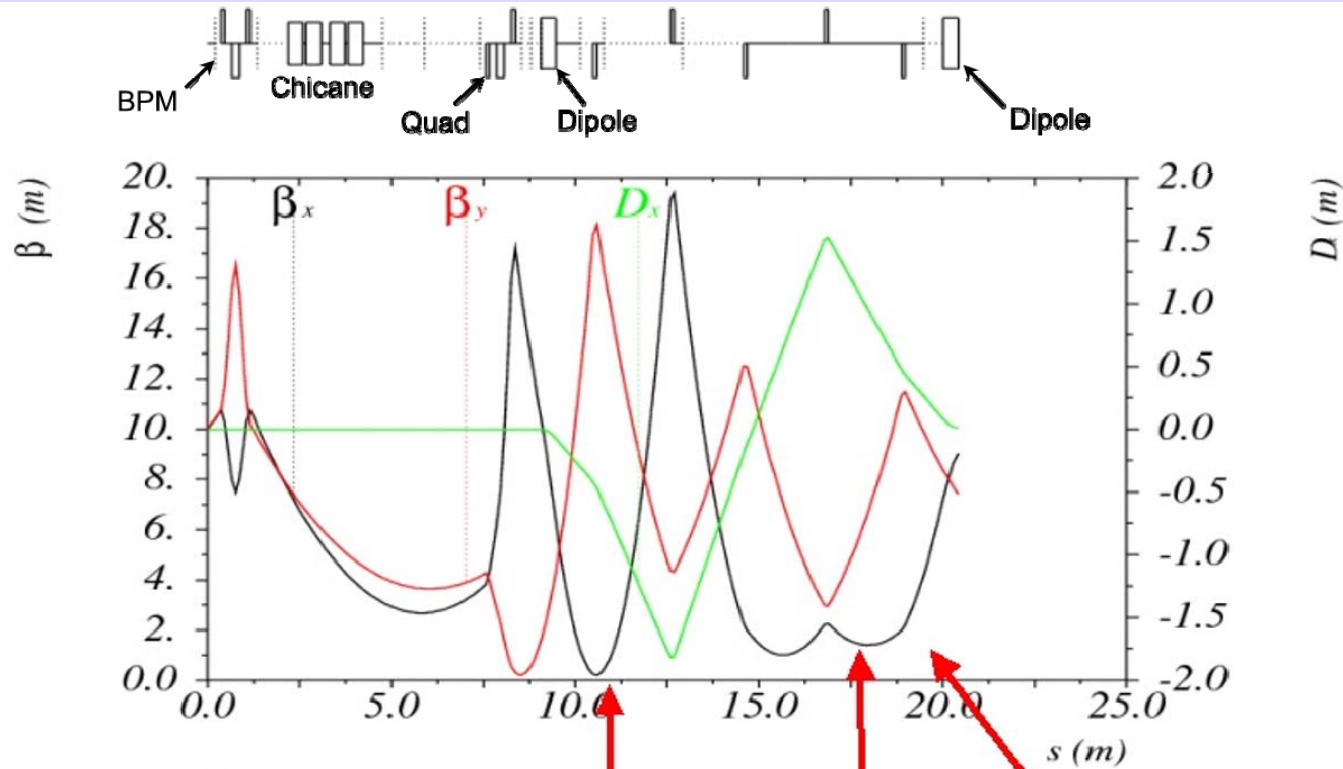
Interferometer data:



Wire mesh:



# $\beta_x$ , $\beta_y$ , and Dispersion Along Beamline



$\delta_E / p_{oc} = 0.$

Table name = TWISS

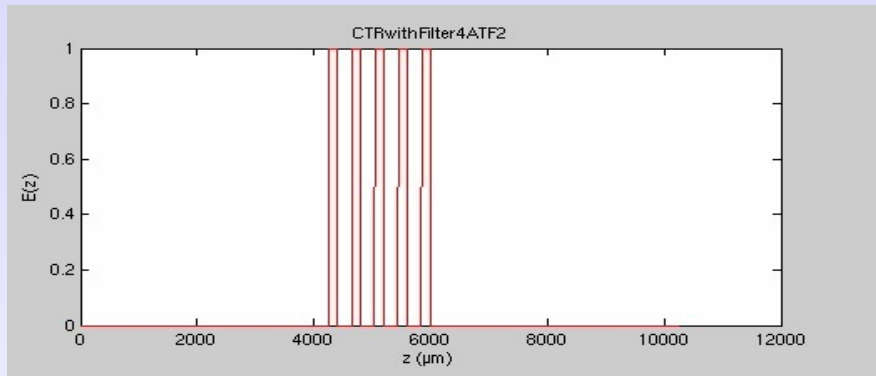
High  
energy  
slit

Wire-  
mesh

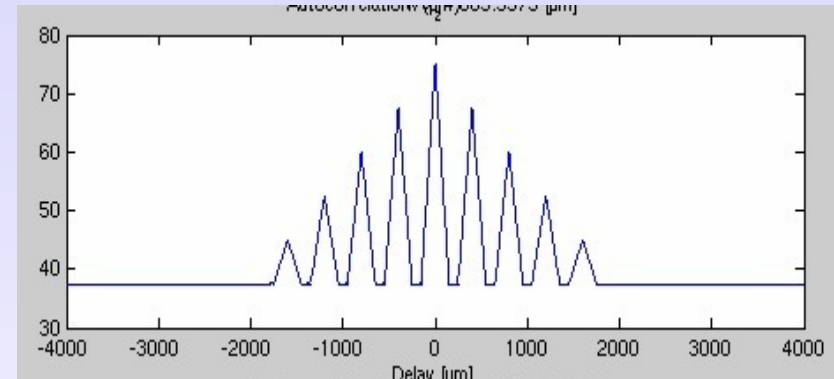
Diagnostics

# Spectral analysis

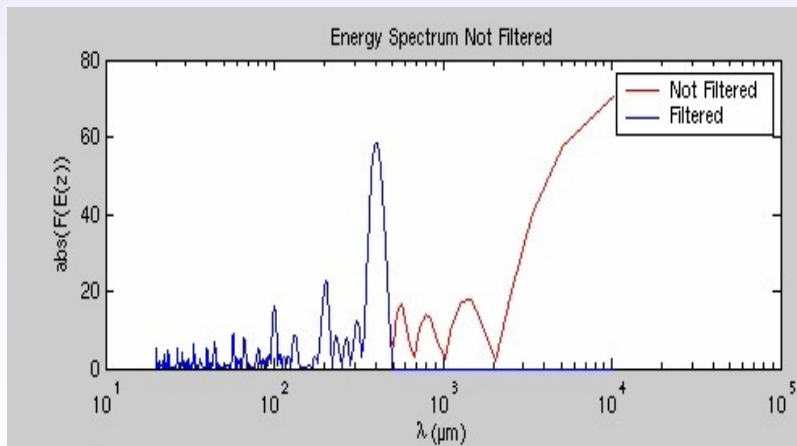
Current profile:



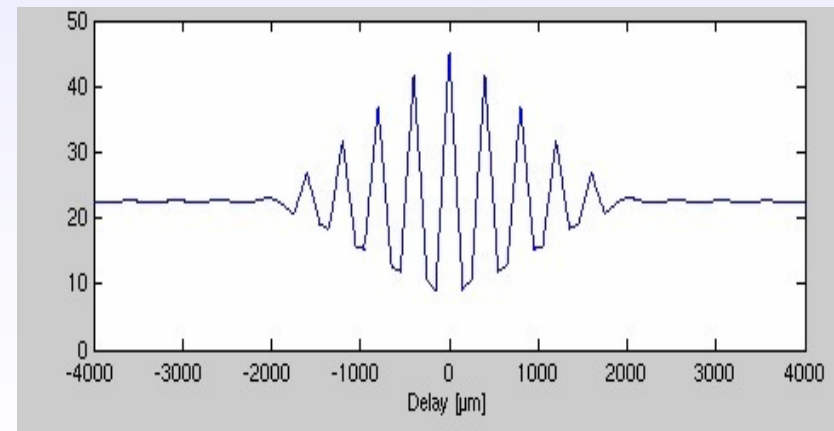
Theoretical interferogram:



Diagnostics has limited bandwidth



"Filtered" interferogram:





# ATF Conclusion

- Demand from user community is very strong
- This was a very productive year but difficult
- Multiple hardware upgrades were done to
  - improve reliability
  - simplify operations and protect components against operator error
  - allow for future upgrades
- 1 micron laser is being upgraded to new technology with new possibilities
- CO<sub>2</sub> laser is on its way to multi terawatt level with reliable operations and adequate diagnostics
- Additional funding from HEP in FY07- FY08 allowed us to address the main issue: to improve support of linac operations